Ecosystem Management and the Use of Natural Resources

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Key questions addressed in this chapter

- Ecosystem use and sustainability
- Compatability between short-term use and maintenance of long-term sustainability
- Healthy ecosystems and healthy economies
- Resource extraction enhances environmental values

Keywords: Forestry, grazing, mining, resource planning, ecosystem health, resource demand

1 INTRODUCTION

Ecosystems have been supporting human life for more than 10,000 years in North America and for even longer in other parts of the world. People have used their environment to extract the goods needed for survival —obtaining food from wildlife, wild plants, cultivated crops, and livestock, and finding shelter from natural areas or making it from plants. Public lands in the United States still supply many of these needs.

In the past, some societies used resources in ways and quantities that were not sustainable. Archeological records from North America indicate that the Anazasi of Mesa Verde and other regions had seriously depleted their forest resources before the sites were abandoned (Cartledge and Propper 1993). Archeological records from other parts of the world tell a similar story – many societies declined after deforestation or improper forest management. For example, the Sumerian empire in Mesopotamia collapsed by 2000 BC, after deforestation of mountains and improper methods of irrigation led to salinity of irrigation water and greatly reduced crop yields. Crete became a commercial power a few centuries later, primarily as a result of its abundant wood supply. Wood was hauled great distances to supply other nations that had lost their forests. Venice, Rome, Cyprus, Egypt, England, and other countries all declined as commercial powers when their forests became depleted (Perlin 1989). Conversely, forest lands that were properly managed enhanced the society's standard of living. In one case, 16th and 17th century Sweden supported its military efforts and empire through use of timber resources (Sundberg et al. 1994).

As outlined in MacCleery and Le Master (this volume), human population growth and resource demand are inextricably linked. Both are increasing at a substantial rate. It is important on both the local and the global scale that ecosystems and resources be maintained and managed to continue to provide a broad array of resources to meet the physical, recreational, and spiritual needs of people.

Management of resources on public lands in the United States has been evolving since the late 1800s, when the conservation movement helped start a system of federal landholdings designed to protect the land while providing for various resource uses. After World War II, an increased level of prosperity created new and greater demands for beef, wood products, and minerals, and a more mobile population created demands for additional recreation opportunities and other services that federal lands could provide. Federal land managers responded to these demands and provided an increasing level and variety of goods and services to the public. During the 1960s and 1970s, a series of legislative mandates provided direction to federal agencies to manage federal lands for a broad array of products and services within a sustainable framework. At the same time, the rise of the environmental movement forced the country to become aware of the effects of increased production of goods and services on the environment. Clean air, clean water, threatened species, biological diversity, and healthy forests and rangeland became increasingly important goods and services provided by federal lands (MacCleery and Le Master, this volume). A new management philosophy, ecosystem management, evolved for federal lands.

Ecosystem management, as currently practiced on public lands in the United States, means managing the lands in ways that ensure, within reasonable limits, that the functionality of damaged ecosystems is restored and healthy ecosystems are sustained. It does not mean that resources are set aside and not used; rather, these lands must continue to satisfy human needs. Its goal is to provide productive biologically diverse ecosystems and ensure quality of life by strengthening the essential connection between economic prosperity and environmental well-being (interagency Ecosystem Management Task Force 1995).

Under the ecosystem approach, goals are developed based on predictions of sustainability and activities are designed to achieve the desired goals at a landscape (regional) level. This regional or ecosystem scale is one of the major differences between the traditional multiple-use management of the past and the ecosystem management of today (MacCleery and Le Master, this volume). Although scale issues are a critical component of the success of ecosystem management, plannmg on regional scales also vastly increases the complexity of management and may create problems in development of criteria to evaluate the accomplishments of land managers (see MacCleery and Le Master, this volume).

Resource managers, who operated efficiently and effectively when agency mandates were clearly understood, public participation was limited, and resources were abundant, often find themselves taxed to the limit given the complexities associated with landscape-level decisions and increased demand from growing populations. When establishing standards for healthy functional ecosystems, resource managers must consider a range of biological, geological, climatic, and political factors. At the landscape level, where landownership patterns are often complex, federal, state, and private management mandates vie for consideration. At the same time, interest groups have become more effective at using the courts and politics to bring pressure to bear on the decision-making process. First-line managers from different agencies also operate at widely varying scales, from Ranger Districts to mineral basins, and from state boundaries to vast river basins. With few exceptions, none of these established boundaries interrelates between agencies, leading to frustration as managers attempt to integrate plans and policies.

The goal of this chapter is to provide guidance to first-line natural resource managers and resource specialists charged with "on the ground" implementation of ecosystem management. These arc the managers who must simultaneously manage resources under their jurisdiction to produce marketable commodities and provide a wide range of non-market amenities within a framework that ensures sustainability of both on a long-term scale, while maintaining functionality in the ecosystem. The complexities of ecosystem management require managers to deal with new issues and consult with a wide range of specialists. Many agencies have hired people in new fields such as landscape ecology, sociology, and decision support modeling. When the appropriate skills are not readily available on-staff, managers who want to make the best decisions must reach out and find these skills.

Although this chapter concentrates on opportunities to find compatibility among potentially competing resource uses, tradeoffs also must be made. Resource managers charged with making these sometimes difficult decisions can benefit from all the chapters in this publication. From *Data Management* to *ecosystem Diversity* to *Public Expectations* and everywhere in-between, this book is designed to assist a manager in these decisions,

This chapter also considers some of the various values that people derive from the ecosystems we manage. The products of ecosystem management, as defined in this paper, are all the resources sought from public lands. They include the materials removed from the land as well as desirable recreational and aesthetic values. Some examples of resources sought from public lands are wildlife and fish, recreation, minerals, wood fiber, grazing for livestock, clean water, and many special products such as Christmas trees, mushrooms, and berries, and the healthy sustainable plant communities that produce them.

Examples are presented of approaches that resource managers and scientists have taken to implement the broad policy directions provided by landscape-level assessments. The scale and scope of these examples range from treatments applied to a few acres, to integrated management plans incorporating millions of acres of land managed under multiple ownerships and jurisdictions. Although the examples vary greatly in focus, they share the common theme of attempting to find ways to understand how best to manage ecosystems to provide multiple benefits at the landscape level rather than produce single-commodity outputs with little or no regard for how each treatment unit relates temporally and spatially to the landscape. Additionally, this chapter will demonstrate ways to calculate just what goods and services can be expected now and in the future while managing for these goals. The authors believe it is critical that managers find a way to integrate the planned production of goods and services into ecosystem management, for without that focus, ecosystem management will be guilty of the same narrowness as the systems it has replaced (see MacCleery and Le Master, this volume).

The approaches are grouped into six emphasis areas: (1) fish and wildlife, (2) recreation, (3) riparian wetland areas, (4) rangelands, (5) nonrenewable resources, and (6) forest management. Case studies are summarized in Table 1.

2 BASIC CONCEPTS OF ECOSYSTEM MANAGEMENT

Any time public land managers make a decision about actively managing the resources, they must deal with a range of issues and concerns about why the action is being taken and what impact it will have on the biological, economic, and social well-being of the land and associated communities. To deal with these issues effectively, land managers must address the following themes related to implementing ecosystem management:

1. *Identify clear objectives* – The objectives need to be based on biological capacity, long-term disturbance history, and economic and social considerations. These objectives must include meeting society's needs for natural resources, either consumptive or nonconsumptive.
2. *Deal with political boundaries* – Managers must recognize and work with different governments (federal, tribal, state, and local) and agencies (Fish and Wildlife Service, National Marine Fisheries Service, U.S. Geological Service (USGS), USDA Forest Service, and USDA Bureau of Land Management (BLM)), all of which have different jurisdictions, regulations, laws, constituents, and functions. Some agencies are set up to map, monitor, and provide development opportunities (USGS), while others try to manage to provide the broadest spectrum of use and protection (Forest Service); even within agencies, rules and regulations vary (Forest Service vs. BLM).

Table I. Ecosystem Management Case Studies.

Resource	Example	Location	Scale/scope	Participants	Approach
Fish and Wildlife	Boise National Forest	ID	Landscape	Forest Service	Conduct risk assessment of multiple management alternatives.
Fish and Wildlife	Feral pig management	HI	Landscape	U.S. Park Service	Restore natural ecosystems while maintaining cultural and recreational values.
Recreation	Idaho SCORTP	ID	Statewide	State and federal agencies, private groups	Develop partnerships by defining common goals.
Riparian wetlands	Muddy Creek project	WY	Watershed	Federal, state, and private land managers	Develop consensus to restore, enhance, and maintain proper functioning condition.
Rangeland	Arroyo Colorado Allotment	NM	Landscape	Federal, state, and private land managers	Improve and maintain health of rangelands without reducing grazing level.
Nonrenewable resources	Columbia River Basin Assessment	ID, MT, OR, WA	Landscape	Federal agencies	Conduct quantitative assessment of mineral deposits within an ecosystem framework.
Forest management	Augusta Creek project	OR	Landscape	Forest Service	Evaluate simulations of future landscape and watershed conditions for habitat, timber, and disturbance risk.
Forest management	Washington Landscape Study	WA	Landscape	Forest Service, university	Evaluate management alternatives that meet wildlife and timber objectives.
Forest management	Ponderosa Pine Forest Partnership	CO	Landscape	County, National Forest, and timber industry	Develop partnership to unite forest health with community sustainability.
Forest management	Crowley Protect	AZ	Landscape	Forest Service	Enhance aspen, diversity, recreation, and timber products through management.
Forest management	Westside examples	OR	Stand.	State, federal, and local agencies; private industry; individuals	Use adaptive management scenarios to integrate habitat, timber, structural diversity, and risk.
Forest management	Eastside examples	OR, CA	Stand	Federal and state agencies, private companies	Evaluate alternative management regimes in fire origin stands of inland NW for effects on stand structure and health.

3. *Tie scales* together – Activity planning starts at the landscape and watershed levels but actually gets implemented at the stand, pasture, or campground level. Evaluations at various scales can give completely different results. Decisions need to be made and evaluations done at the correct geographic and temporal scales.

4. *Work closely with public* – The public should be seen as something more than a group of people who must be educated. The public needs to be involved throughout the activity planning process to help establish common goals and action plans and be treated as partners. The combined support and energy of a larger group is a key component to the success of implementing ecosystem management. Lack of understanding of short-term and long-term results and consequences between alternatives is one of the major factors leading to disagreements on alternative management scenarios.

5. *Assess alternatives for multiple resources* – Integration of multiple disciplines, legislative authorities, scales, and time frames is the art of ecosystem management. Managers are responsible for assessing alternative ways to meet varying needs, including some that are in conflict with each other. Conducting risk assessments of multiple management alternatives for a variety of resources is a key element of this responsibility. The ability to develop possible actions that can be combined into alternatives to maximize achievement of multiple goals simultaneously is important.
6. *Deal with economics and social needs* – Cost effectiveness of treatments, economic well-being of communities, and effective use of scarce financial resources need to be included in the overall evaluation of projects.
7. *Implement, adapt, and monitor* – The most effective tool that a manager has is to actually conduct business on the ground as promised and then monitor the results to determine if the activity produced acceptable results. Adapting management and activities to new information learned from research and monitoring is important to producing healthy, diverse, and productive natural resources.

3 CASE STUDIES

3.1 Fish and Wildlife

Among the most challenging problems facing managers of public lands in the United States is the management of fish and wildlife. Frustrations occur partially because federal land managers do not have direct authority over fish or wildlife populations, yet management practices are supposed to ensure viable populations of these species. As a practical matter, this means that each land manager not only faces constraints imposed by the most sensitive of (typically) 300 to 500 recognized fish, amphibian, reptile, bird, and mammal species, but also must deal with the interests and legal requirements of those agencies that do have management authority. That authority is split among several agencies. State fish and wildlife management agencies have the mandate for managing resident species (i.e., those fish and wildlife species that typically reside within a drainage basin year around, such as most fish species, amphibians, reptiles, nonmigratory birds, and most mammals) and particularly game species (e.g., trout, bass, deer, elk). Most migratory species (and all species classified as threatened or endangered under provisions of the Endangered Species Act of 1969 as amended) are managed by federal agencies. The National Marine Fisheries Service manages threatened and endangered anadromous fish and marine mammals, and the U.S. Fish and Wildlife Service manages migratory birds and threatened and endangered nonmigratory fish, amphibians, reptiles, birds, and mammals. These agencies often have limited flexibility. In the case of threatened and endangered species, constraints are imposed not only by federal law (National Forest Management Act, Endangered Species Act), but also by international law (Convention on international Trade in Endangered Species) and treaties. State agencies typically face economic constraints as well. In most instances, funding for agency operations is based on the sale of licenses and tags for fishing and hunting, which often occur on public lands.

There are other, less obvious, reasons associated with the frustration public land managers often feel when faced with the management of fish and wildlife. The first of these is a recreational (and therefore, social) concern. Fishing and hunting is a major, if not the major, recreational activity on public lands, attracting many people and generating tremendous economic impacts (U.S. Fish and Wildlife Service 1993). Second, public concern is often driven by the perception of scarcity (and therefore, value) of public land, particularly areas that are deemed as special places because of some perceived unique quality, such as a roadless area. Because these services are perceived as both unique and scarce, perceived public value for protection of fish and wildlife resources (usually through protection of particular areas) is often very high. These concerns are provoked and aggravated by commodity production values for timber or livestock forage. As private goods and services, timber and grazing are relatively abundant and market-driven, providing direct economic benefits to a small private sector and indirect benefits to end-users, but at some cost to non-market, public resources. Thus, decisions that may affect fish and wildlife populations are almost always controversial.

In addition to such social concerns, some subtle biological concerns exist. Management implies manipulation, and manipulation of habitats often results in long-term changes to both the terrain and the development of vegetation (i.e., fish and wildlife habitat) through time. Both have important implications. Road development increases sedimentation in area waters and directly affects the degree of silt deposited in stream gravels. Silt, in turn, affects the viability of aquatic insect populations and both the food base and spawning area available to fish populations. Roads, even if closed to human travel, provide attractive travel corridors for most medium and large wildlife species, changing patterns of habitat use. Because roads are also attractive to hunters, they increase the vulnerability of game animals to harvest (an effect vastly multiplied when roads are left open to vehicular access). Changes in vegetation often have a bewildering number of both immediate and long-term impacts on fish and wildlife populations (Maser 1988). Habitats are fragmented (Harris 1984), and because the turnover rates of fish and wildlife populations differ dramatically from stand recruitment rates (and from each other), changes through time will not be in synchrony with current situations.

As a simple example, the harvest of a single tree in a riparian area can have immediate effects: a reduction in stream shading (which contributes to warming of the water temperature); reduction in local food supply (seeds, buds, insects) for a variety of amphibians, reptiles, birds, and small mammals; elimination of critical nesting habitat for songbirds and small mammals; and effects on travel corridors (e.g., screening and resting places) for a wide range of species, from amphibians to birds and large mammals. Over the long term, harvest of this same tree might reduce the contribution of woody debris (essential for fish hiding places and stream thermoregulation) to the stream; eliminate a potential snag necessary for woodpeckers, owls, or other birds or mammals, and subsequently the fallen wet, rotting wood necessary to support a local amphibian population; and (by opening the canopy) change the site to a younger seral stage of willows, supporting an entirely different group of local species.

So what does a manager do? Because these concerns are unavoidable, are there any guidelines? In fact, there are. The following examples demonstrate, at least in part, key factors that affect public land decision-making as identified by Yaffee (1994) in his analysis of the spotted owl controversy in the Pacific Northwest. These factors include the heightened complexity of management issues associated with expanding and conflicting public values, the ambiguous and conflicting norms of collective choice, and the inherently complicated future environmental issues. Yaffee also identified a reduced capacity to meet demands, resulting from declining slack in the natural resource base and in the ability of government to act proactively because of discouraging fiscal realities, unstable coalitions because of fragmented power and interests, and limited vision and guidance from elected and appointed officials and the management institutions they control. Based on his analysis, Yaffee identified four essential components for building more effective agencies and the decision-making process:

1. New mechanisms to bridge the agency-non-agency boundary to build understanding and political concurrence.
2. Altered approaches to organizational management, including updated notions of leadership.
3. Improved means of gathering and analyzing information about resource problems, organizational possibilities, and political and social context.
4. Ways to promote a culture of creativity and risk-taking to generate more effective options for the future.

3.1.1 Evaluation of limber Sales Effects on Forest Birds on the Boise National Forest in Idaho

This case study focuses on approaches used to identify the effects of a proposed timber sale on the long-term viability of two forest bird species, the pileated woodpecker (*Dryocopus pileatus*) and flammulated owl (*Otus flammeolus*), documented by Erickson and Toweill (1994).

Case study attributes
Scale: Secondary
Scope: Environmental analysis
Instrument: Formal
Participants: Forest Service and state fish and game agency staff
Duration: 30-year planning horizon

Background

The species of interest in this example have specific habitat needs that feature mature stands of timber. Past harvest practices changed the composition of native stands, reducing suitable patch size, altering dominant timber stands, reducing and fragmenting suitable habitat, and increasing susceptibility to further alteration through effects of insect pests, fire, and normal patterns of plant succession. The forest had experienced catastrophic increases in insect and disease infestations, associated with an increase in the number of stems per acre following decades of fire prevention and livestock grazing in a fire-dominated ecosystem. Wide areas were facing high risks of extensive stand-replacing wildfires, and treatment was clearly demanded, both to reduce risks and to increase the potential for future productivity. An analysis of hazards clearly demonstrated that the risks pertained to not only the vegetation in the area but also the continued viability of fish and wildlife populations. In other words, the no-action alternative itself contained a threat of massive ecological change because of clearly identified risks.

Geographic area
The area included in this analysis was the 15,000-acre Logging Gulch Timber Sale area, plus adjoining habitats within the potential dispersal range of the bird species of concern.

Project description
This analysis examined the amount of suitable habitat and its present distribution, and it identified potential risks and plant succession patterns to evaluate the distribution of suitable habitats to the 30-year planning horizon,

The analyses focused on key species and critical habitats currently available for each (spatial analysis). Direct impacts to critical wildlife habitats were modeled for a variety of alternative management proposals (including no action). Then, a species-by-species population risk model featuring population demographic characteristics [minimum size of required habitat], habit& quality and distribution, and vulnerability to catastrophic events (wildfire, flood, landslides) was applied to the remaining critical habitats. Five- and 30-year projections of vegetation response to potential current hazards and each proposed management alternative were then examined to estimate effects of changes in habitat quality and distribution through time associated with each alternative. Each projection was analyzed to ensure that critical habitats for each species were well distributed and in sufficient proximity to each other throughout the analysis period to maintain viable populations. These models were developed and reviewed with other agencies having management responsibilities, providing each agency a basis for full evaluation of potential risks and benefits of each alternative, including the no-action alternative. Although not reported here, similar analyses were completed for impacts to several populations of game animals.

Outcome
The outcome of this approach was to explore graphically the full range of predictable risks of all alternatives, including the no-action alternative, given what was known about the functional ecosystem and specific habitat requirements of the species of concern. This approach significantly reduced confusion about the potential effect of proposed actions and resulted in much interagency consensus and support.

Lessons learned
The first and most important lesson is that vegetation regimes are constantly changing naturally, and that lack of direct intervention by human activities does not equate to protection in perpetuity. Any long-range planning to ensure ecosystem sustainability must explicitly identify and strive to predict natural changes in succession as well as changes resulting from human activity. The second lesson is related to the temporal scale of changes – to sustain ecosystems, all critical components for any species must be maintained and be accessible to the organisms of concern throughout the entire planning cycle. Many plants and most animal populations turn over completely (and some many times) within the typical tree life cycle, and loss or inaccessibility of critical habitat components during any portion of this period can result in loss of sustainability of natural resources. The lesson is based, explicitly or intuitively, on risk assessment. Landscapes are exposed to many risks, from fire to invasion by undesirable species. Ensuring ecosystem sustainability demands a conservative approach to landscape alteration on a temporal scale, and it should be accompanied by redundant safety mechanisms such as several discrete areas of habitat for a given species in the event of unforeseen losses.

Evaluation
The approach used can be generalized to any fish and wildlife species (or group). However, it is information-intensive, which limits its application to a small number of wildlife species of particular interest if time or funding is limited.

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3.1.2 Removal of Pigs From Hawaiian National Parks

Although it is easy to see that the protection and management of native species is vitally important from an ecosystem management viewpoint, management of non-native species is less clear. This example identifies some approaches used to manage a non-native species.

Case study attributes
Scale: Secondary
Scope: Management plan
Instrument: Formal
Participants: Interagency
Duration: indefinite

Background
Pigs were probably initially brought to the Hawaiian Islands by Polynesian settlers between 1,200 and 1,500

years ago. Populations of feral pigs were consequently supplemented by releases of domesticated European pigs (Baker 1979, Vtorov 1993), and feral populations reflect strong influence of European stocks. Feral pigs have been implicated in alteration of native flora and fauna, both through direct actions such as foraging (Singer 1981) and indirect actions such as development of wallows (Baker 1979) and dispersal of non-native plant species. Although removal of pigs has been advocated by restoration biologists, removing pigs from an area will not by itself eliminate problems associated with non-native plant species (Huenneke and Vitousek 1990).

Pigs are important in Polynesian culture and provide recreational hunting opportunities for residents (Anderson and Stone 1993). Support for elimination of feral pigs from the ecosystem is not universal, and removal efforts are strongly opposed by some groups. State forests are managed to provide both recreational hunting and sustained yield of feral pigs, among other things (Katahira et al. 1993), and most control efforts have been limited to National Parks. Past pig control efforts on National Parks included public hunts (Stone and Loope 1987), but hunts proved to be largely ineffective when populations were low, partly as a result of ingress of pigs from other areas. Although poisoning is used elsewhere (Hone and Stone 1989), it is not acceptable in Hawaii because of the potential for adverse secondary poisoning effects and social concerns.

Geographic area

Hawaiian Islands, specifically Hawaii Volcanoes National Park on the island of Hawaii and Haleakala National Park on the island of Maui.

Project description

Two projects are described here. The first, the Hawaiian Volcanoes National Park or HAVO Project (Katahira et al. 1993), was conducted on the island of Hawaii. The second, the Kipahulu Valley Project, was conducted in the Haleakala National Park on the island of Maui (Anderson and Stone 1993).

The HAVO Project focused on three of nine fenced enclosures totaling 19 acres in the Hawaiian Volcanoes National Park. Pig control methods included hunting with dogs, trapping, baiting, and snaring. Eradication was achieved in all nine fenced units over the course of 3 years. Professional hunting with dogs was the most effective control method, although public hunting proved ineffective as a method of eradication. In the Kipahulu Valley Project, snaring was the only method used to eradicate pigs in two fenced units. This project was apparently successful in eradicating pigs from one unit and greatly reducing their numbers in the other. The success of this project led to the adoption of snaring techniques by groups such as the U.S. Fish and Wildlife Service, the Hawaii Department of Forestry and Wildlife, The Nature Conservancy Council of Hawaii, the Maui Land and Pineapple Company, and other landowners who manage natural areas in remote locations.

Outcome

Where pig control is an objective, secure barriers are necessary to confine pigs or restrict their access. Sturdy fences with barbed wire at ground level are effective but require constant maintenance. The methods of fence construction and therefore the costs depend on the types of animals being confined or restricted (Katahira et al. 1993). Maintenance of fences in areas with cattle requires taller and sturdier fences with a second strand of barbed wire along the top (Hone and Atkinson 1983). Snaring pigs in unfenced areas can considerably reduce populations, but may not eliminate the pigs. Without continued control efforts, populations will quickly reach precontrol levels (Anderson and Stone 1993).

However, it is still unclear how, or if, the removal of pigs by itself will contribute to the restoration of natural Hawaiian ecosystems. Available evidence suggests that some characteristics of the natural ecosystems, such as soil microarthropods, may return to normal without further active management. Even when pigs are removed, other non-native species such as rats and snails remain. The ability of these animals to prevent the restoration of natural ecosystems will be an imp ortant factor in determining the success of restoration efforts.

Lessons learned

Changes in ecosystem function may be associated with a single invasive species, but they are often associated with impacts of multiple species. Although gains can be made by significantly reducing or eradicating some undesirable species, recovery may be impossible without a multifaceted approach. Eradication of undesirable species, where possible, is time-consuming and difficult. It often demands developing and maintaining impervious barriers to recolonization. Control methods outside of impervious barriers can reduce populations over the short term but only as long as efforts are maintained; populations may recover quickly when control efforts are reduced or terminated.

Contact person

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3.1.3 Idaho Comprehensive Outdoor Recreation and Tourism Plan

The Idaho comprehensive outdoor recreation and tourism plan (SCORTP) provides an example of the many opportunities provided by an interagency, federal-state cooperative framework.

Case study attributes
Scale: Primary
Scope: State management plan
Instrument: Formal
Participants: Interagency
Duration: Definite

Background
Each state is required to prepare a comprehensive outdoor recreation plan to be eligible for certain matching funds under the Land and Water Conservation Fund Act of 1965

Geographic area
Statewide

Project description
Under the leadership of the Idaho Department of Parks and Recreation, development of the Idaho SCORTP was broadened to include participation by other state agencies with a role in recreation (including the Departments of Recreation, Commerce, Fish and Game, and Water Resources), federal agencies (including six Idaho National Forests, BLM, Bureau of Reclamation, and National Park Service), and private groups (including the Idaho Association of Counties, Idaho Association of Cities, Idaho Recreation initiative, and Idaho Foundation for Parks and Lands). Participants identified 15 recreation goals, such as to improve maintenance and provide recreation and tourism infrastructure and services, to promote a unified communication and marketing program, and to promote and maintain high quality fish and wildlife recreation opportunities. Each goal was reviewed by all participants, who identified whether the goal was central to their organization's mandate (allowing them to assume a leadership role), included within the mandate (allowing formation of partnerships), not excluded by the mandate (allowing a supporting role in some situations), or excluded by the mandate.

Outcome
The primary outcome of this exercise was the creation of a partnership framework that identifies opportunities for forming partnerships. Moreover, the synergy created by this process resulted in explicit identification of objectives and resources, which has resulted in pooling of efforts, expertise, timing, and (in some instances) funding. Thus, more is being accomplished under this unified framework than would have occurred had the partners separately pursued their own interests. In addition, this process has enhanced the opportunity to mesh projects; for example, while one agency planned to develop a public boat ramp, another developed a riverside park in a nearby area. This process has also reduced the potential for conflicts; open communication about plans prevent situations such as promoting recreational fishing in an area where fish populations are depressed.

Evaluation
This open process resulted in an interagency network of people with differing perspectives but common goals of providing recreational opportunities in Idaho. Once objectives were identified, many potential avenues for future development of partnerships and pooling of limited resources were identified, creating synergy between the partners and smoother delivery of recreational opportunities to a wide range of customers.

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3.2 Riparian Wetland Areas and Effects of Livestock Management

Although riparian wetland areas constitute less than 9 percent of the 270 million acres of public lands being managed by the BLM, these areas are the most economically and environmentally valuable. In 1991, the BLM launched a nationwide program called the Riparian Wetland Initiative for the 1990s (Platts et al. 1987, Debano and Schmidt 1989, Myers 1989, Welsch 1991, Elmore and Kauffman 1994). One of the chief goals of this initiative is to restore and maintain riparian wetland areas so that 75 percent or more of riparian areas are properly functioning by 1997.

The overall objective is to achieve the widest variety of vegetation and habitat diversity for wildlife, fish, and watershed protection. This objective is important to remember because riparian wetland areas will function properly long before they achieve an advanced successional stage. It is also well to remember that the management goals for the area and the corresponding desired plant community may not correspond with the potential plant or natural community.

The functioning condition of a riparian wetland area is a result of interaction among hydrology, land form/soils, and biology. Riparian wetland areas are functioning properly when adequate vegetation is present (1) to dissipate stream energy associated with high water flow, thereby reducing erosion and improving water quality, (2) to develop the filter sediment and flood plain, (3) to improve floodwater retention and groundwater recharge, (4) to develop root masses that stabilize the streambank against erosion, (5) to develop diverse ponding and change characteristics to provide proper habitat and water depth, and (6) to provide shade for extended duration with cool temperatures necessary for fish production, breeding, and other uses and support greater biodiversity.

The definition of proper functioning condition (PFC) is then translated into a set of minimum national standards consisting of checklist criteria for determining the PFC. The checklist criteria are developed by a national-level interdisciplinary team for three components: hydrologic, biological, and erosion deposition. The process of assessing whether a riparian wetland area is functioning properly requires a team of specialists in vegetation, soils, and hydrology. A biologist also needs to be involved because of the high fish and wildlife values associated with riparian wetland areas. After each riparian wetland area is assessed, the area is classified into one of four categories: PFC, functional at risk, nonfunctional, and unknown. For areas that arc functional at risk, an assessment should be made of the trend (upward, downward, or not apparent).

Management actions are then developed to consider such factors as critical water quality problems, potential for improvement, risk of further degradation, threatened and endangered species habitat, and fisheries and recreational values. Areas identified as functional-at-risk with a downward trend are often the highest management priority because a decline in resource value is apparent but can usually be restored in a cost-effective manner. As most riparian values have already been lost, restoration of a nonfunctional area is often not cost-effective and usually receives a low priority.

The effectiveness of each action must be assessed as management actions are being implemented through various prescriptions, such as regulating livestock grazing practices while accommodating uses; developing water for dispersed grazing; planting trees, shrubs, and grasses; constructing fences; and conducting prescribed burns. Progress toward meeting PFC must be documented through monitoring. Sites should be revisited periodically as part of the overall monitoring progam, which reflects long-term trends. With a change in management, most riparian wetland areas can achieve PFC in a few years, although some will take years to achieve the identified desired plant community or advanced ecological status such as late-seral and natural plant diversity conditions.

When determining whether a riparian wetland area is functioning properly, the condition of the entire watershed is important, including the upland and tributary watershed system. The entire watershed can influence the quality, abundance, and stability of downstream resources by controlling production of sediment and nutrients, influencing streamflow, and modifying the distribution of chemicals throughout the area. Although a healthy riparian wetland area does not necessarily indicate a healthy watershed, an unhealthy watershed will eventually cause damage to downstream riparian areas.

Muddy Creek Project

The Muddy Creek drainage is located in south-central Wyoming in the upper Colorado River. This watershed encompasses nearly 300,000 acres of mixed federa1, state, and private lands in Carbon County and had become rather degraded. Although there was no formal assessment and classification of the riparian area, it was certainly in the functional-at-risk condition, at best, before restoration work began in the early 1990s.

Management plans had been developed for the entire watershed. However, in the 1990s, a coordinated resources management (CRM) group was initiated to focus on management in the upper half of the perennial headwaters of the drainage. The CRM project, one of the original National Seeking Common Ground demonstration projects, was initiated by the local conservation district to promote consensus among all affected interests as opposed to confrontational management of the natural resources in the project areas To date, more than 25 members are working together to restore, enhance, and maintain the abundant resources in the area while maintaining the economic stability and cultural heritage of the people on the land.

Throughout the watershed, improvements in the health of rangelands (including riparian) have been the result of shorter duration of use and improved management rather than reduction in livestock numbers. The following techniques are being used:

- Water is piped from the creek to a tire trough; the overflow returns to the creek. These sites have reduced the effects of cattle trailing and trampling along stream banks.

- Upland water development is resulting in better distribution of livestock on land and is reducing impacts on riparian areas by both livestock and wildlife.
- Cross fencing is being used to divide large pastures to shorten the duration of livestock use in a given area. The fencing is built to address wildlife concerns; for example, barbed wire fences have a smooth bottom wire to allow small game and antelope to pass under the fence.
- Prescribed burning is used to restore the ecological balance that was lost in the last 100 years of fire sup pression. Such burning increases grass cover, which reduces soil erosion, and also increases plant diversity, thus improving habitat and forage for wildlife and livestock.
- Several types of in-stream structures are utilized to repair and improve the riparian zone and fisheries habitat. Although the natural system will eventually repair itself, these structures speed up the process.
- Nearly 10,000 seedlings of many plant species have been planted in the past 2 years to accelerate woody plant revegetation. Woody plants are important for bank stability, stream shading, and wildlife habitat. Revegetation of native woody plants is often a slow process, but it is important to the healing of the riparian habitat.
- Roads are sources of sediment. In addition to educating the public who drive through the area, several measures are being used to address this problem: placing water bars across roads, eliminating or replacing stream crossings with culverts, rerouting roads, signing roads for voluntary non-use, and closing roads.

Lessons learned

Wildlife, livestock, and all the associated natural resources, including the proper functioning riparian areas in the watershed, have improved since the initiation of the project. The greatest indication of success is the people story: many people with diverse backgrounds and interests who are working together lo develop trust, respect, and commitment to an overall vision and conservation ethic on land management.

Contact persons

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3.3 Rangelands

The BLM is steward for 177 million acres of western public rangelands. During the past 30 years, public land-users and managers have learned much about how nature works. The BLM recognizes the progress that has been made in improving public lands, but at the same time it believes that greater success requires a broader approach, one that considers more fully how living things interconnect and affect each other. Success also requires enabling all people who share an interest in public lands to collaborate in finding lasting solutions. The current grazing regulations reflect these ideas (Herbel 1985, Laycock 1991, Cool 1992, Sharpe et al. 1992, National Research Council 1994).

3.3.2 BLM Goals and Practices

The goals of BLM rangeland management are:

1. to improve rangeland health to provide lasting benefits for users of public rangelands and future generations,
2. to assist rural western communities in building stable economies on a foundation of sustainable resources, and
3. to ensure that public lands users have a meaningful say in managing public lands.

The grazing regulations require establishment of resource advisory councils (RACs) to provide meaningful participation in BLM resource management programs. Councils represent diverse interests, employ consensus decision-making, and can provide advice to the BLM on land management issues. The RACs play an important role in helping to design state or regional standards and guidelines. Regulations also require the establishment of standards and guidelines for grazing administration, which should be developed at the state or regional level to reflect geographic differences and to involve stakeholders. Standards and guidelines must be based on the fundamentals of rangeland health, which emphasize improving watersheds, restoring areas near streambeds, protecting water quality, and supporting healthy plant and animal communities.

Many rangelands on public lands in the western United States are not healthy by current standards, mainly as a result of improper grazing practices (e.g., overgrazing), lack of adequate facilities (e.g., sources and distribution of water, fencing, and cattle guards), and out-of-date management plans for improving rangeland condition. To restore these lands to a healthy condition could mean a permanent or temporary reduction in grazing levels for the allotment. In the following success story, the allotment has been managed to restore and maintain the health of a rangeland without reduction in animal unit months (AUMs) (an AUM is the amount of forage needed to sustain one cow, five sheep, or five goats for a month) allowing year-long grazing use in the allotment. There have been situations where a reduction in AUMs was necessary to maintain the health of the rangeland. In most of these cases, operators were persuaded to adopt the new practices without appeals. These are success stories as well.

A full AUM fee is charged for each month of grazing by adult animals if the grazing animal (1) is weaned, (2) is at least 6 months old when entering public land, or (3) will become 12 months old during the period of use. For fee purposes, an AUM is the amount of forage used by five weaned or adult sheep or goats or one cow, bull, steer, heifer, horse, or mule. The term AUM is commonly used in three ways: (1) stocking rate, as in *x* acres/AUM, (b) forage allocation, as in allotment A, and (3) utilization, as in *x* AUM consumed from unit B.

3.3.3 Arroyo Colorado Allotment

Geographic area

The Arroyo Colorado allotment is located 35 miles west of Los Lunas, New Mexico, in Cibola County. The valley of the Arroyo Colorado, which is surrounded by rough, broken topography and mesas, is approximately 16 miles long and 79 miles wide. Elevations range from 5,600 to 7,200 ft. The allotment is 72,165 acres or approximately 113 square miles, including 46,910 acres of public land, 14,135 acres of private land, and 11,120 acres of state land. The allottee has a stock of 670,680 animals, which include cattle and horses. A total of 48 of 8,156 AUMs are reserved for big game (e.g., mule deer, pronghorn antelope); 68 percent of the forage capacity for livestock is on public lands.

Project description

The Acoma Pueblo purchased the allotment from Wilson Cattle Company in October of 1978. In 1984, because of their interest in improving the condition of the rangelands and producing a more efficient and economical cattle operation, the Pueblo entered into a cooperative management plan with the Soil Conservation Service and BLM. To implement the plan, which would initially be an eight- to nine-pasture deferred rotation grazing scheme, the Pueblo have constructed pasture fences, a water pipeline, storage tanks, retention dams, and cattle guards. They also developed springs, and maintained existing roads and dams. The Pueblo wants to improve rangeland condition and its cattle breeding program, calf crop, and calf size, which will ultimately increase their profit. The average shipping; weight of calves in recent years has been 500 lb.

The 1977 range survey showed that 96 percent of the allotment was in either poor or fair condition. Since 1984, many signs have indicated that the condition has improved, primanly as a result of better facilities and the diligent effort of the range manager and staff in inspecting and monitoring the range condition and frequent herding through pastures to prevent overgrazing.

The new management approach has resulted in the following changes:

- bare areas have been filled in with perennial cover and fewer annuals are growing
- many seedlings of alkali sacaton and fourwing saltbush are growing in alluvial grassland areas
- more vegetation is growing along the eroded banks of the Arroyo Colorado
- more plant and animal litter are accumulating
- vegetation is growing near watering places
- vegetation is holding the soil in place
- increased cover is decreasing the rate of evaporation from the soil surface

During the 1989 drought, the allotment had more forage than did the surrounding allotments, even though it received no more rainfall. Moisture was not a limiting factor because the vigor of the Individual plants was at a higher level. The forage withstood drought because soil moisture was held available for a longer time.

Lessons learned

The manager has observed plant growth in each pasture and has moved livestock when necessary; livestock have been moved frequently to take advantage of forage quantity and quality, which has improved rangeland health. The trend of range condition has apparently been improving, as indicated by heavier calves and by the fact that the BLM has been able to transplant pronghorn antelope into their historical range.

This project shows that it is possible and practicable to improve and maintain the health of rangelands without a reduction in grazing level. It shows that the level of Interest of the local grazing manager is the key to successful implementation of improvements. Lastly, it shows that prompt response to changes in local forage condition are critical to achieving long-term improvement in the condition of the ecosystem.

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3.4 Nonrenewable Resources

Mineral resources are one of the products that the public demands from public lands. Ecosystem management for nonrenewable resources is different than that for renewable resources. For renewable resources, we assure long-term sustainability by changing or using the resource at a replaceable rate only. This is not possible with nonrenewable resources by definition. Thus, the emphasis in ecosystem management for nonrenewable resources is to take steps to assure compatibility with reclamation of sites and minimum impacts on other values.

Knowing what, where, and how many mineral resources exist, or are likely to exist, in an area can help meet management objectives. Mineral assessments are one way to supply this information. Two mineral assessment approaches are used: qualitative and quantitative. The U.S. Geological Survey and the former Bureau of Mines have conducted qualitative mineral resource evaluations for approximately 44,000,000 acres of federal lands since the Wilderness Act of 1964 was implemented. This work has identified or ranked areas for mineral potential and has helped in recognizing the need to exclude many mineralized areas from wilderness designation. Results of 20 years of qualitative assessments for approximately 80 areas are summarized in Marsh et al. (1984).

Quantitative assessment allows a quantitative comparison of the value of mineral resource development to development of other resources (Singer 1993). Undiscovered resources have been the focus of this approach. Quantitative assessment requires forecasting, an activity most geologists do not relish. Federal geologists rarely have the option of selecting the regions that they will assess. These areas commonly lack obvious signs of undiscovered mineral deposits. The Government uses assessments in multiple ways, and the results are subject to public scrutiny. To facilitate the assessment process, a three-part quantitative assessment approach was developed to allow economic comparison of undiscovered mineral deposits to other competing land uses (Singer 1975) and to satisfy information needs of land management (Fig. 1). This quantitative assessment includes (1) delineation of areas permissive for specific mineral deposit types, (2) estimation of undiscovered mineral deposits using subjective methods or spatial models, and (3) development or use of models of grade, tonnage, and other characteristics of each mineral deposit type (Singer 1993).

Two types of ecosystem management decisions involve mineral resource development, those required for proposed mineral development in the management region and those involved in making land allocations during resource management planning. To make these decisions, tracts of various existing or proposed land-use designations and ecosystems in the management region are superimposed at appropriate scales. Once this has been done, some areas may be found to have ecosystems that are sensitive to mining and are therefore excluded. Other areas may allow mineral development, but mining may be conducted only with constraints. Limitations on mineral development need to be clearly defined to private sector mining corporations during the leasing phase or prior to their entry into an area for locatable minerals. Examples of possible constraints include no surface occupancy or surface occupancy prohibited during certain seasons related to wildlife migration or breeding activity.

If a site is proposed for future mining, the reclamation plan needs to be an integral part of the mine plan. When the mine is decommissioned, will it meet ecosystem management goals such as returning the site to its approximate pre-mining state? If pre-mining conditions are not possible, will surface modification and other modifications be compatible with long-term ecosystem requirements? Mining, as compared to other land uses (e.g., timber production, grazing), affects small areas. Often, the size of the area disturbed by mining is similar in size to areas changed by natural disturbances (Salwerowicz 1994). In addition, active mining is a short-term event when compared to the long life of ecosystems. However, the type of changes to the sites can be very different. It is the state of the post-mining site and its long-term impact in the ecosystem that need careful evaluation (Ripley et al. 1996). Resource extraction may occur, given that ecosystem management sees that the needs of the ecosystem as a whole are met (Salwcrowicz 1994).

Mining may be used to help reclaim lands originally disturbed by mining activity by reworking metalliferous mine tailings left by previous operations. Additional processing of the tailings removes more metal and reduces the amount of potentially toxic materials available to the ecosystem. Reducing the volume of tailings remaining from past placer mining activity or of coarse waste rock left by other types of mining is possible if the material is suitable for use as aggregate. Disposal of reworked material can be done in ways that meet ecosystem management goals. Assessments would need to provide appropriate data on tailing and waste material characteristics. No example of this type

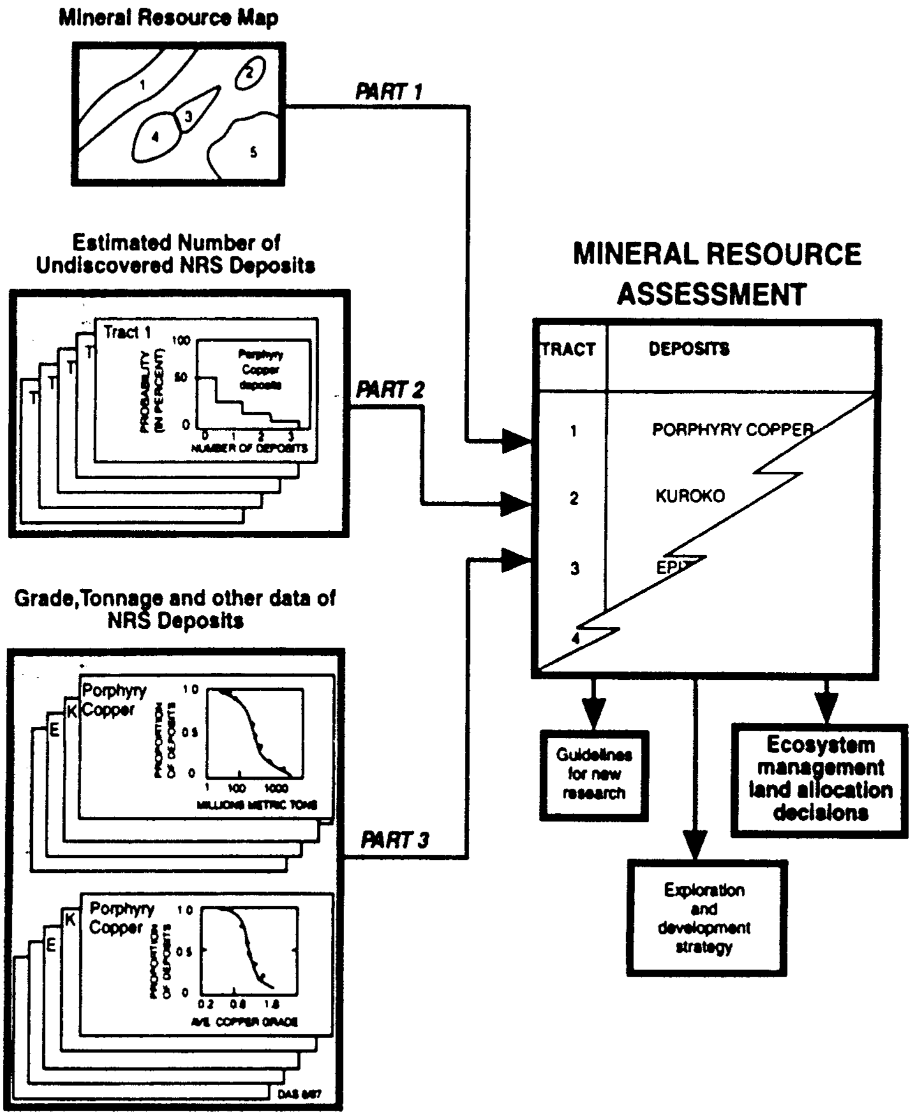

Fig. 1. Quantitative nonrenewable resource assessments comprise three parts, which can be applied to land allocation decision in ecosystem management land allocation (modified after Singer, 1993).

of approach in mineral assessment could be found, but it may represent a promising new direction.

Example Projects

Spanski (1992) demonstrated the general use of quantitative assessment, and Gunther (1992) described its use in economic analysis. More than 27 quantitative mineral assessments covering more than 1.2 billion acres have been completed (Singer 1993). Most assessment areas were in the United States, but assessments were also conducted in selected areas of Central and South America.

The result of most quantitative mineral resource assessments appears to be the modification of boundaries between lands of different designations. For example, land boundaries affecting State of Alaska and Native Corporation lands were changed after the completion of the mineral resource assessment of Alaska in the late 1970s (D.A. Singer, personal communication, 1996). Assessment reports are frequently used in the evaluation of land for property exchanges or land acquisitions.

Tongass National Forest assessment

The Tongass National Forest assessment in Southeast Alaska (Brew et al. 1992) estimated the gross-in-place value (disregarding costs associated with exploration, development, and extraction) of undiscovered metals at $23.5 billion. The resulting action was the creation of a land-use designation for mineral management prescription. The number of areas so designated increased from 6 to 12 in the draft EIS land management plan.

Interior Columbia Basin Ecosystem Management Project

In January 1994, the Chief of the Forest Service and the Director of BLM, under the direction of President Clinton, initiated a study that eventually became known as the Interior Columbia Basin Ecosystem Management Project. Its initial goal was to develop a strategy for dealing with anadromous fish habitat and watershed conservation; the project was eventually expanded to include all of the Columbia River Basin (parts of Idaho, Montana, Oregon, and Washington), plus southeastern Oregon. (Note: Information on the Interior Columbia Basin Ecosystem Management Project is from a written communication from T.P Frost, 1996.)

The overall goals were to provide management tools that can be used to sustain or restore ecosystem integrity, to promote products and services desired by society over the long term, and to provide ways to balance ecosystem conditions, resource uses, and competing needs of stakeholders. Pursuant to these goals, assessments were also made of current and historic landscape conditions, aquatic and terrestrial habitats, species distributions and populations, and economic and social conditions. The project produced scientific assessments of the potential future conditions and possible tradeoffs likely under a number of different disturbance scenarios and management practices.

The Geological Survey was asked to provide estimates of the value of undiscovered mineral resources for the Interior Columbia Basin Ecosystem Management Project using quantitative mineral resource assessment. The results are summarized in Box et al. (1996), Bookstrom et al. (1996), Zientek et al. (1996), and Bookstrom et al. (1995). Knowledge about the presence of existing mineral deposits was used in economic and social assessments and helped to identify sites possibly disturbed by past mining. Information on existing metallic mines and potentially undiscovered deposits (and possible infrastructure related to extraction, benefaction, and processing) was considered in the landscape ecology assessment. A map derived from the lithology map, which showed where sand and gravel was likely, was used to identify areas or tracts currently or likely to be disturbed by mining. The tract boundaries are part of the assessment of aquatic and riparian ecosystems. This map was also found to be useful in the economic assessment. The phosphate mineral resource map was used in a similar fashion for terrestrial ecosystem and economic assessments.

Earth science information was relevant to assessments of past, current, and potential ecological, economic, and social conditions in the area. Bedrock lithology was used to assess aquatic integrity and to identify areas likely to contain some possible roosting sites for cave-dwelling bats (Johnson and Raines 1995). Areas with limestone caves and lava tubes are likely, as are adits and other underground structures of past mining, to contain this habitat (Frost et al. 1996). A number of derivative maps were prepared using bedrock lithology, together with rock chemistry (Raines et al. 1996) and regional geochemistry (Raines and Smith 1996), to help evaluate terrestrial and aquatic ecosystems. Information on hazards associated with earthquake (Algermissen et al. 1990) and volcanic activity (Hoblitt et al. 1987) was explicitly included in evaluation of the landscape ecosystem.

Lessons learned

Good mineral assessments can lead to good ecosystem planning and management by providing information on possible future mineral development impacts, so that this information can be integrated in plans for other resource uses. Mineral assessments assist especially in transportation planning, but also in trade-off analysis and land allocation to various uses. They can help with socioeconomic analysis, ecosystem restoration plans, and aquatic integrity. In a few instances they have also led to expanding other ecosystems such as aquatic habitats.

3.5 Forest Management

As forest managers make the transition from managing for single product or species outputs and values (e.g., timber, endangered species) to managing for multiple outputs or values on a broader scale (e.g., provenance, landscape, watershed, century-long time-frame), they seek ways to maintain ecosystem diversity and health. This transition concentrates attention during the planning phase on how actions at one location affect ecosystem attributes in other areas and the structure of the landscape in total.

3.5.1 landscape-level Background

Most first-line forest managers typically encounter questions regarding management on areas ranging from a few to about 100,000 acres (Forest Service Ranger District) and occasionally as large as a National Forest or BLM District (+500,000 acres). The analytical unit is typically a watershed or drainage, and questions revolve around what types of treatments arc needed within the watershed to restore or maintain its ecosystem function or how groups of watersheds might be summed to achieve sustainability on larger landscapes. Managers must look at time frames that are decades or centuries long and try to understand how conditions and activities today will play out over time.

The landscape-level case studies are intended to provide ideas about how to address these two types of problems. We outline examples of analyses at different spatial scales, which include a watershed level analysis (Augusta Creek project), implementation of a restoration plan for a Ranger District (Ponderosa Pine Forest Partnership, Crowley Project), and landscape analysis and planning tools for large areas (Washington Landscape Study).

Within these examples and throughout the forest management community, there are recurrent themes, or challenges, that must be addressed to implement ecosystem management successfully in our public forests. The challenges tend to involve restoration of riparian health and function or changes in species composition and stand structure, and they are manifested at the stand or project level rather than the landscape level. These smaller scales are the levels where on-the-ground activities occur and where the landscape-level concepts of ecosystem management become reality. In recognition of this fact, we include information on the state-of-the-art in addressing stand- or project-level issues. These studies add to the tool kit available to resource specialists who advise first-line managers in developing the stand-level prescriptions that ultimately sum to landscape-level decisions. We chose examples that include research-scale implementation of treatments and extend the range of activities well beyond those envisioned for production forestry.

3.5.2 Stand-Level Background

In the northwest United States, project-level examples typically apply generically to either coastal areas west of the Cascade Mountains or the interior east of the Cascades. Stand-level approaches to management will be briefly summarized for each area. For the most part, these approaches are being tested as research projects and can be considered as “promising possibilities” at present.

Westside examples

Much of the federal land west of the Cascades is covered by the Northwest Forest Plan for the Recovery of the Northern Spotted Owl (USDA Forest Service and RLM 1994). A recurring theme on these lands is to hasten the development of late-successional structure in areas that were previously managed as single-species plantations intended to maximize timber production.

The scale of this task can be daunting. The Siuslaw National Forest covers about 660,000 acres, with approximately 200,000 acres of plantations less than 30 years old. Only about 60,000 acres are designated as Matrix or areas with primary emphasis on timber production, while the remainder falls into various other land allocations where timber management is restricted or excluded. Although the Siuslaw may be an extreme case, other larger National Forests also have considerable areas of young plantations, e.g., 350,000 acres on the Willamette National Forest (Mayo 1995); many of these National Forests fall within areas with restricted management options. Although no detailed survey exists, it is safe to say that there are millions of acres of young plantations that were originally established to maximize timber production but now will be managed for other objectives. Managers are faced with the problem of changing stand trajectories in an attempt to create a mosaic of species composition and stand structures in a relatively short time-frame. The new objective is to perpetuate a healthy, productive, biologically diverse forest that will continue to have social and economic outputs.

Eastside examples

On the eastside of the Cascade Mountains, problems associated with small-diameter, densely stocked stands are common. These stand types tend to create large, structurally uniform areas; successful implementation of ecosystem management in the West will require workable management strategies for these areas. Some of these stands have a component of larger, older trees but all share a dense small-diameter component. The stands often arose as a result of successful fire suppression efforts, and all contain timber that is of marginal value.

Situations where all the trees in a given area are small diameter might occur when stands arose after stand replacement fires in the early part of the century, followed by successful fire suppression over the past 70 or so years. Situations where there is a component of large-diameter trees in the stand are common in ponderosa pine stands, where periodic low-intensity fires have been excluded. In both cases, late-successional structure might be created by active management, and commercial thinning will sometimes be the appropriate tool.

3.5.3 Augusta Creek Project

Geographic area

The Augusta Creek project is located on the Willamette National Forest in western Oregon. It includes areas designated as wilderness, unroaded areas, areas where timber harvest is prescribed, and an aquatic reserve system.

Background

The goal of ecosystem management on public lands means maintaining native species, ecosystem processes and structures, and long-term ecosystem productivity. However, we currently lack the knowledge necessary to state accurately and completely how native species, ecosystem processes, and productivity can be sustained. Recognition of this condition led to using a relatively conservative approach to human use of ecosystems, which relied on past conditions and natural patterns as guides for future management designs.

Project description

The Augusta Creek project (Cissel and others, in press) was initiated to establish and integrate landscape and watershed objectives to guide management activities within a 19,000-acre planning area. The preliminary objective was to maintain native species, ecosystem processes and structures, and long-term ecosystem productivity in a federally managed landscape where substantial acreage has been allocated to timber harvest.

A landscape management strategy was developed that uses past landscape conditions and disturbance regimes to provide key reference points and design elements for future landscape objectives. One premise of this approach is that native species have adapted to the range of habitat patterns resulting from disturbance events over thousands of years. The probability of survival of these species is reduced if their environment is maintained outside the range of these historical conditions. Similarly, ecological processes, such as nutrient and hydrological cycles, have historically functioned within a range of conditions established by disturbance and successional patterns. Management activities that move structures and processes outside the range of past conditions may adversely affect ecosystems in both predictable and unforeseen ways. A second premise of the strategy recognizes that existing conditions of human use must be integrated with this historic template to meet long-term objectives.

The analytical process involved five sequential phases. Work in each phase was conducted in the context of the larger surrounding watersheds and was designed to efficiently link to implementation of management objectives.

Fire history – A fire history study was conducted within the planning area over the last 500 years. Plot level data were used to map 27 fire events. The maps were used to reconstruct and analyze vegetation patterns within the same 500-year period.

Analysis of conditions, processes, and uses – Several approaches were used to analyze the aquatic system and hillslope-to-stream connections. Landslide and debris-flow occurrences and potential for future occurrences were mapped from aerial photographs, existing maps, and field surveys. Relative susceptibility of the landscape to rain-on-snow peak flows and contributions to summer baseflows were mapped. A time-series analysis of aerial photographs spanning 40 years was used to assess riparian vegetation dynamics and disturbance history. Both prehistoric and contemporary human uses were described and mapped. Current human uses included hiking, camping, angling, hunting, and harvest of timber and special forest products.

Landscape objectives and prescriptions – The planning area was subdivided into three general categories so that specific landscape management objectives could be developed:

1. large reserves from the Willamette National Forest
2. landscape areas for prescribed timber harvests
3. an aquatic reserve system

Projection of future conditions – Maps of future landscape and watershed conditions were developed by simulating the growth of existing forest stands using a simple stand-age model in the Geographical Information System (GIS). Following timber cuts, blocks were reset to specific stand conditions, according to a timber harvest schedule determined by the landscape objectives and prescriptions for the area. Growth was again simulated until the next scheduled cutting. A set of maps depicting future landscape conditions was gencrated at 20-year intervals for the next 200 years.

Evaluation – The Augusta Creek landscape design (ACLD) was evaluated by comparing it to the future landscape generated by application of standards, guidelines, and assumptions in the Northwest Forest Plan (NWFP).

Results from the landscape maps show a gradual change in the landscape from the relatively fragmented forest of today to one dominated by larger blocks and containing a wider array of stand types as described in the landscape objectives. By the year 100, the future landscape appeared significantly different from the existing landscape. Gradual change continued before stabilizing in the year 200. The conclusions of the study are as follows:

I. The ACLD appears superior for most taxa evaluated, especially those dependent on large patches of old forest habitat.

2. Compared to the NWFP, the landscape in the ACLD is much less fragmented and is expected to be less susceptible to wildfire, wind, and insect disturbance.

3. The NWFP is superior with respect to providing more early serial habitat.

4. The board-foot yield of timber is about 6 percent higher under the NWFP scenario. However, this increase is within the error terms of estimates and thus would be considered equal for either plan. Timber value may be higher under the ACLD scenario because of larger, higher value trees.

5. Hydrology and debris slides and flows are expected to differ little between the two scenarios.

Lessons learned

The project provides an example of how ecosystem management activities on a project level can be linked to wider objectives, standards, and guidelines established on a much larger scale. Specifically, Augusta Creek can be viewed as a post-watershed analysis implementation of the Northwest Forest Plan. Although the general approach to landscape management should be generally applicable to other landscapes, the mix of specific design elements and the resulting consequences will likely vary considerably. The ability of ecologists and land managers to incorporate new perspectives for ecosystem management is limited by several factors, including the lack of analytical and modeling approaches to landscape-scale problems. Although many of the required components are currently available, or are the subject of ongoing research, more effort should be directed to projecting and evaluating the effects of land-use actions on the sustainability of ecosystem properties from both ecological and social perspetives.

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3.5.4 Washington Landscape Study

Geographic area

The Washington Landscape Study is located on state land on the Clallarn River at the western end of the Olympic Peninsula.

Project description

The Washington Landscape Study (Cary et al., in press) was initiated by the Department of Natural Resources (DNR) of Washington State. The objective was to evaluate management alternatives across land ownerships that meet the needs of wildlife in late-serial forests while minimizing impacts on the production of commodities. A major reason for choosing this area was that the DNR had developed a substantial database on this landscape and had adapted the database to the SNAP-II landscape simulator.

A conceptual model of landscape management, specific to westside western hemlock-Douglas-fir forests, was developed using ecological theory and concepts. The biodiversity alternatives included conservation of biological legacies at harvest (soil food webs, coarse woody debris), both planting and natural regeneration, precommercial thinning, favorable density thinning long (70-130 year) rotations, and differing degrees of intervention. Four riparian management schemes were used: the Washington Forest Practices Board (WFPB) regulations, two FEMAT-like approaches, and a variable polygon scheme that emphasized protection of stream banks and thinning to promote development of large trees. Four new indices of forest ecosystem health were developed, as well as several economic measures relating to timber harvest. The SNAP-II simulations were conducted for a 300-year period.

Many alternative landscape management scenarios were developed. The key scenarios were as follows:

- No manipulation, with protection of the entire landscape.
- Protection of wide riparian buffers with maximum net present value (MAX NPV) of timber on remaining areas.
- MAX NPV using protection of riparian buffers, using current WFPB regulations.
- MAX NPV using more frequent intervention (thinning at 30, 50, and 70 years with final harvest at > 110 years).
- MAX NPV using less frequent intervention (thinning at 30, 60, and 90 years with final harvest at > 130 years).
- Maximization of biodiversity with alternating 70- and 110-year rotations.
- Selection of 30 percent late serial forest (LSF) for biodiverslty simulations, including 20 percent in niche diversity and 10 percent in fully functional managed forests.

Some results of the management scenario simulations are as follows:

- No manipulation – 180 years required to meet the 30 percent LSF goal; no commodities produced (NPV = 0); ecological crunches occurred before forest maturity (crunches would lead to continued species declines or extinctions).
- Protection using wide, FEMAT-like buffers – More than 200 years required to meet 30 percent LSF goal; LSFs badly fragmented by intervening intensively managed forest; NPV = $48.5 million.

- Maximization of net present value – No LSFs; inadequate riparian protection; >25 species at risk; NPV = $70.3 million.
- Other intermediate results.

Results

Results from the economic analysis of costs showed managers the following:

- Transition costs from present to regulated state can be large.
- NPV depends on timing of incentives.
- Estimated present value cost for each 10 percent increase in LSF could be as low as $100/acre.
- This approach is a net benefit solution for managers of multiple-use public lands.

Salient points about regional benefits are as follows:

- Diversification of wood products industry
- Increased secondary manufacturing
- Increased direct employment
- Increased indirect employment
- increased tax revenues

All of these regional gains are substantial compared to the suggested incentive programs. However, details of the gains vary markedly with the assumptions made.

Lessons learned

This project provides an example of state and federal cooperation to explore alternatives for implementing ecosystem management objectives across multiple land-ownerships while minimizing impacts on the production of both plant- and animal-based commodity projects. This approach highlights the ability to identify a wide variety of ecological, social, and economic benefits under various management alternatives. However, it also highlights the sensitivity of the projected results to the input assumptions. Thus, the project shows how analytrcal projects can be used not only for making land management decisions but also for identifying key assumptions that require better documentation prior to implementing study results.

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3.5.5 Ponderosa Pine Forest Partnership

The Ponderosa Pine Forest Partnership (PPFP) practices community-public lands stewardship by building relationships that unite forest health with community sustainability. This multi-member partnership emerged from a recognition of common needs created by a weakened local timber industry and declining forest health. The PPFP has learned how commercial logging can restore badly needed forest health and how the National Forests can support local communities in the spirit of ecosystem management. The Partnership has replaced gridlock and uncertainty with constructive action.

The PPFP was initiated when Montezuma County submitted a proposal to the USDA Rural Community Assistance program and won a grant for $25,000. An agreement was made among the county, the San Juan National Forest, and the Colorado Timber Industry Association to share time and data, seek markets for small-diameter timber, and hire geographical information system (GIS) mapmakers and ecology researchers.

Geographic area

The PPFP is a demonstration of adaptive management techniques on 189,000 acres of southwest Colorado's ponderosa pine forests located on the Mancos-Dolores Ranger District within the San juan and Rio Grande National Forests. Second-growth pine and a thick understory of Gambel oak dominate the terrain found between 7,500 and 8,500 ft throughout the area. A century of heavy logging, cattle-grazing, and fire suppression have created an unnaturally dense and stagnant ponderosa pine forest at risk of mountain pine beetle infestation and catastrophic wildfire.

Project description

From 1950 to 1980, the San Juan Forest timber harvest averaged 45 million board feet (mmbf) per year. Since 1980, it has averaged 24 mmbf, with 12 mmbf harvested in 1994 and 1995. Mill closings marked these later years. About 65 years of timber-related activities, combined with federal agency control of about 75 percent of the land, profoundly shaped local culture and social values. Today, nearly one-third of the District's timberland is second-growth ponderosa pine.

Using tree-ring dating and analysis, ecologists from Fort Lewis College and Northern Arizona University assessed pre-1870 ponderosa pine forest fire history, as well as current ecological conditions across the 189,000-acre study area. Long-time local residents were interviewed as other researchers examined historical uses and past management of these local pine forests. The ecologists speculate that before European settlement, periodic fires, whose frequency averaged 5 to 40 years, created a landscape characterized by large and widely spaced ponderosa pines, ground vegetation dominated by native grasses, and scattered thickets of younger pine regeneration. Stumps still surviving from turn-of-the-century logging show that before 1870, trees were as large as 27 inches in diameter and numbered 40 to 50 per acre. This is considerably different from today's situation. Now, the average size is about 8 inches and there are 280 to 390 trees per acre. Most trees are less than 90 years old. Open grassy areas are uncommon. Wildfires in the pine zone have been actively suppressed for the last 100 years.

The PPFP hallmark is the cooperative development of a GIS map database to facilitate understanding of ecosystem relationships and provide the basis for a strong public involvement process. To develop the vegetation maps, stand exam data were put into GIS format and used to classify and map areas of risk for pine beetle. The Forest's Integrated Resource Inventory (IRI) team provided detailed GIS maps and data about on-site conditions and capabilities. All the mapped data were used to recommend the best sites and priorities for treatment.

The predominance of small-diameter trees makes conventional sawtimber sales and pricing infeasible. The demonstration work is designed to find a feasible and fair approach to ecosystem restoration that maintains timber management as part of the rural culture. Forest Service and Colorado state foresters formulated silvicultural prescriptions to conduct forest restoration at the project sites. The key objective has been to restore vegetative diversity that mimics the diversity that had been caused by natural disturbances before 1870. The prescriptions specify removal of many smaller trees, leaving all trees 16 inches and larger. In the past, only the larger trees would have been harvested. Harvests have been designed to help create a more clumped appearance and create openings for natural regeneration, much like presettlement conditions. The few large trees that remain provide important habitat for plant and animal species not found in the second-growth forests.

The reintroduction of fire is a key element of this restoration project. After locally contracted loggers have completed harvesting these stands, Forest Service crews will conduct prescribed burns. Periodic follow-up bums will be scheduled at various intervals for up to 10 years. Areas will be closely monitored to evaluate the effectiveness of treatments in reducing fire and disease risk and promoting pine regeneration.

Simultaneously, local timber industry representatives are testing new timber harvesting techniques. Colorado State University (CSU) developed a plan to help the timber industry monitor the efficiency of new equipment and logging methods. CSU has also taken an active role in researching alternative product opportunities for small pine material. The PPFP goals hinge heavily on identifying marketable products from small-diameter trees.

The PPFP goals also rely heavily on pricing for the raw materials. Historically, raw materials from small pine do not convert into valuable end-products. The primary appraisal system for valuing timber in the Forest Service does not accurately reflect the much-reduced markets for smaller material. Stewardship contracts have been considered that would allow the contractor to perform needed land management activities and, in turn, be given salvage rights to the raw material.

lessons learned

Federal, state, and local governments and many local cooperators, each with different goals, can all work together to achieve their respective goals through ecosystem management. "The challenge," as one partner says, "is to develop a community stewardship model that allows communities to be active players in making ecological and community sustainability work together." The strategies that reduce pine beetle and wildfire risks, increase plant and animal diversity, and establish a sustainable flow of wood to local communities have become a model for managing second-growth ponderosa pine forests on public lands in the West.

Contact person

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3.5.6 Crowley Project

Geographic area

The Crowley Project was undertaken on the Cocoino National Forest in Arizona. The objectives were to enhance recreation, vegetative diversity, and visual quality while maintaining production of wood products.

Background

Throughout the U.S. inland west, aspen forests ecosystems are aging and are often being replaced by conifer forests. This is part of the natural succession process, which has been going on since the last Ice Age. However, since European people became a dominant force in the area, one major change has occurred: far fewer new aspen stands are being created. Under natural conditions, aspen sprouts rapidly after periodic crown fires, creating new stands of younger age classes to replace older stands that are burned or replaced by conifers. Whether the stand that burns is mostly pure aspen or whether conifers take over, the extra sunlight and heat provided to the forest floor by removing the overstory causes prolific sprouting from the aspen roots. The shoots grow rapidly, resulting in a pure or near-pure aspen forest.

Ungulate grazing (which removes fine fuels and also aspen suckers) in the last half of the 19th and early 20th centuries, fire control, and timber harvest by selective methods have all contributed to the lack of new aspen regeneration. Most recent inventories in Arizona (Connor et al. 1990) and New Mexico (Van Hooser et al. 1993) show declining acreages from previous inventories, but increasing volumes. Photographs previous to the 1950s show aspen stands where conifers predominate today.

Even though aspen is not considered a valuable species from a wood standpoint, ecologists, wildlife biologists, silviculturists, landscape architects, and other resource managers recognize its high value for scenic beauty, wildlife habitat, and biological diversity as well as the variety it provides in forests usually dominated by conifers. The solution to aspen regeneration and overall maintenance of acreage of aspen stands seems fairly obvious: harvest, burn, or a combination of these to remove the overstory and allow new aspen forests to develop. However, in real life, many other factors immensely complicate the implementation of these activities. In the Crowley Project, success has been achieved in improving the ecosystem while also producing wood products for society.

The vegetation in this management block is largely dominated by a sea of ponderosa pine, mostly pole and small sawtimber size. However, scattered through the area are several small aspen clones, ranging from only 10 to 15 trees up to 1 to 2 acres in size. These small groups of aspen provide much-needed diversity and visual variety in an area with little topographic or vegetative diversity. The small aspen clones are uniformly very old and are being crowded out by ponderosa pine. When the aspen try to regenerate with new suckers, they are decimated through grazing, primarily by elk, but sometimes by livestock as well. The result is aspen clones that are dying slowly as the old trees die.

Besides aspen loss, four other environmental concerns needed to be addressed in the Crowley block: (1) invasion of meadows by ponderosa pine, (2) lack of age-class diversity, (3) loss of opportunities to view large yellow-pine trees, and (4) overly dense forests, which are not allowing optimal tree growth and creation of large trees and old-growth conditions over time. Older ponderosa pine with yellow bark (often called yellow-bellies) is highly desirables for viewing. However, over the last 100 years, much of this species has been harvested in the Crowley block. The remaining yellow-bellies are often hidden from view by the sea of smaller pines surrounding them. Additionally, as a result of the dense stocking of the small trees, growth of each tree is extremely slow, so large yellow-bellies are not being developed for the future

Project description

A project was designed to improve conditions for the aspen clones as well as for visual quality, tree growth, and diversity. No aspen trees were harvested because of their extremely low number. However, ponderosa pine trees less than 16 inches diameter at breast height (dbh) within and in a circle about 75-ft-wide around each clone were harvested to open the area to sunlight. Harvest disturbed the ground, enhancing aspen sucker production. A total of 20 aspen clones are being treated in a 496-acre area. Each clone is being enclosed in a 6.5-ft-high fence to prevent elk and livestock from browsing on the new aspen shoots. Past research indicated that such fences must be maintained for about 7 years until the new trees are large enough so that elk browsing will not cause significant damage. This fencing is a very expensive (approximately $6,000 per mile of fence), but a necessary part of this project.

Pines are also part of the Crowley Project – removing pines that are invading meadows creates new age-classes for diversity, removing small pines from large pine stands enhances viewing opportunities, and thinning enhances tree growth. An associated recreational value enhanced by the Arizona Department of Game and Fish is increased levels of elk hunting.

Besides these recreational and environmental benefits, the Crowley Project is also producing much-needed raw materials for local industry and consumers. A total of 14,160 hundred cubic feet (CCF) of timber is being harvested. Of this, 6,850 CCF is pulp (5 to 8.9 inch dbh) and 7,310 CCF is sawtimber or trees greater than 9 inches dbh. Total value returned to the Government from this sale is $410,153.

A significant part of increasing aspen regeneration is eliminating or reducing the amount of browsing by elk. In Crowley, the existing population of aspen did not provide the opportunity to create enough new aspen stands to provide more new shoots than the elk population could use. However, one promising possibility is that where there is more aspen, it should be feasible to harvest larger areas and thus eliminate the high cost of fencing. Along with the harvest, another possible measure is to (temporarily) reduce the elk herds in the area through hunting. In northern Arizona this is being done by the Arizona Game and Fish department. In Game Management Unit 7 around San Francisco Peaks, permits have been increased as follows: 1991 and 1992, 1,275 permits; 1993, 1,375 permits; 1994, 1,475 permits; 1995 and 1996, 2,147 permits. In the long run, this will diminish elk numbers, or at least minimize increases, and the consequent impact on aspen regeneration.

Lessons learned

The Crowley Project is an outstanding example of enhancing aspen, diversity, and other environmental quality factors, enhancing recreational opportunities and quality, and producing wood for meeting consumer demand. Current forest management activities have made significant progress in moving the area toward a sustainable condition, although it will take 100+ years to get there. The timber sale is the most cost-effective way to achieve needed environmental improvements.

Contact person

Jim Rolf, Peaks Ranger District, Coconino National Forest (tel. 520-527-8239). There are many other areas where aspen is being enhanced through ecosystem management projects. In some of these areas, aspen is much more dominant (including pure stands) than in the Crowley area. Two other contacts with expertise and knowledge of projects involving aspen are (1) Wayne Sheperd, Rocky Mountain Station, Fort Collins, CO (tel. 303-498-1259) and (2) Dale Bartos, Intermountain Research Station, Logan, UT (tel. 801-755-3567).

3.5.7 Colville study

The Colville Study (Barbour et al. 1995, Ryland 1996) was an integrated study intended to help natural resource managers understand the silvicultural, operational, and economic implications of performing forest operations in small-diameter, densely stocked stands. This study was a cooperative effort involving the Colville National Forest, Idaho Panhandle National Forest, Ochoco National Forest, USDA Forest Service Forest Products Laboratory, Boise Cascade, Riley Creek Lumber, Vaagan brothers Lumber, Oregon State University, University of Idaho, University of Washington, Washington State University, and Forest Service Pacific Northwest Research Station.

Geographic area

The study focused on the Rocky II timber sale on the Colville National Forest in northeastern Washington. The sale consisted of 18 separate cutting units, totaling 764 acres of thinning that were representative of the densely stocked, small-diameter stands in the forest. A recent inventory had found 115,000 acres of small-diameter, densely stocked stands (Colville National Forest 1994).

Project description

The objective of the forest managers was to develop a strategy for changing the trajectories of the small-diameter, densely stocked stands in an attempt to (1) create late-successional structure from large areas of uniform stands, (2) decrease forest health risk, (3) improve wildlife habitat, particularly for white-tailed dear and cavity-nesting birds, and (4) improve stand aesthetics.

Various silvicultural regimes and residual densities were modeled using the Inland Empire variant of the Forest Vegetation Simulator (FVS) for four different stand types. Future stand structures were judged according to their success in providing large-diameter trees, large snags, overstory height, crown height, and other factors. The modeling exercise illustrated that changes in the pattern and rate of stand development could be induced through silvicultural treatment to create desired ecological features and generate timber outputs. The most evident change was the development of large-diameter trees, which could provide large snags for cavity-nesting birds and other wildlife as well as sawtimber. These simulations illustrated the effects of varying degrees of disturbance and suggest that meeting stated ecosystem objectives will require some form of intervention to allow stands to develop the necessary structural and habitat characteristics.

A harvester forwarder system was monitored during harvesting of the Rocky II timber sale, and production functions were developed for the system. Additional work is in progress to develop similar functions for small tractor logging systems. Lumber and veneer recovery studies were conducted to develop grade and volume yield equations for small-diameter logs. Suitability of the material for several composite products and mechanical and kraft pulps was also determined. Reports on these studies are forthcoming.

A financial analysis package is also under development. This package is intended to help timber planners understand what types of treatments are feasible and can be accomplished using timber sales, when thinning contracts are the best option, and when costs will be so high that a hands-off approach is the only option.

Lessons learned

The ecosystem objectives outlined by the forest managers would not be met in a reasonable timeframe (less than 200 years) if no treatment was done. Any of the other treatments would meet the objectives sooner, but the economics of harvesting and processing the small-diameter material is extremely sensitive to piece size and market conditions. Harvesting and processing small material is expensive, and the quantity and value of the resulting products are fairly low. Designing timber sales so that the purchaser can react quickly to fluctuating markets is one way to increase the likelihood that timber sales will sell and ecosystem management objectives will be reached. Finally, the economic evaluation of timber stands for possible sale is very complex. A computer program is needed to understand the interactions of the various components.

Contact person

Jamie Barbour, Portland Forestry Sciences Laboratory, Portland, OR (tel. 503-326-4274).

3.5.8 Blacks Mountain Experimental Forest Project

In the rush to create stands with diverse species and structures, it is not known whether we can manage old-growth stands to perpetuate their values over time. Information about how old-growth stands have responded to thinning treatments is as useful as information on whether younger stands can be manipulated to accelerate the creation of late-seral conditions. In 1938, research was initiated on thinning old-growth stands of eastside pine types, which contained large trees (31.5 inches dbh, about 5 tpa) at least 300 years old. At that time, the stands were influenced by frequent low-intensity fires and sheep grazing, which kept the understory open and fuel levels low. With the end of sheep grazing and the exclusion of fire, a dense understory of ponderosa pine and white fir has developed.

Geographic area

The Blacks Mountain Experimental Forest is located in northeastern California. The study area is roughly 10,000 acres of interior ponderosa pine cover type, locally known as eastside pine. This cover type is found on about 2.3 million acres in California, nearly 14 percent of the total available commercial forest in California.

Project description

Six levels of thinning, from a no-thin control to 95 percent removal, were tested on the Blacks Mountain Experimental Forest (Dolph et al. 1995). Measurements were taken at 5, 10, 20, and 50 years after treatment for tree growth, volume production, diameter distribution, and species composition. Results show that the diameter growth was greater on the more intensive treatments, which result in smaller stems; volume production was initially decreased in the intensive thinning, but significantly increased in the 20-50-year period, probably because of in-growth; and diameter distribution showed a consistent increase in trees <27.5 inches dbh, regardless of treatment, and a decrease in trees >27.5 inches dbh in intensive thinning. Finally, although no relationship was found in species composition between treatments, an increase in competition from the in-growth in the understory contributed to the mortality of large trees, even in the control. Major changes on the study plots were observed for both the exclusion of fire and the thinning treatments.

Lessons learned

The decline of the old, large-tree component demonstrates an important point that other authors have reported: characteristics or functions of old-growth stands cannot be guaranteed in perpetuity by simply preserving existing old-growth tracts (Debell and Franklin 1987). Like young-growth stands, old-growth stands must be managed for desired attributes.

Contact person

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4 CONCLUSIONS

Ecosystem management provides the opportunity to produce and use natural resources in ways that ensure, within reasonable limits, sustained ecosystem functions. In fact, ecosystem management includes providing for the needs of humans. We face the continuing challenge of finding ways to forecast how ecosystems are likely to respond to changes related to the production and use of our resources. The resources desired from public lands include wildlife and fish, recreation, minerals, wood fiber, forage for livestock, clean water, and many special products, including Christmas trees, mushrooms and berries.

Planning is foremost in importance as we face the challenge of meeting ecosystem management goals. We found that users of public lands must be involved in developing regional standards and guidelines. Planning at the regional scale must become a collaborative effort, including all levels of government as well as industrial and private cooperators. Planning at the site-specific level must be linked to wider objectives as is shown in the Augusta Creek example. Partnerships must be forged and planning integrated on a landscape basis to mesh agency responsibilities and pool personnel and funding resources. We have shown several examples (e.g., Washington Landscape Study, Recreation, Muddy Creek, Ponderosa Pine Forest Partnership) where such effort has been successful. Resource uses must be monitored to prevent over-use and degradation, or to ensure restoration as in the Rangelands example in the Arroyo Colorado allotment.

Alternative management practices for resource production need to be evaluated to determine possible impacts on the health of the ecosystem. State and federal agencies, working together, are beginning to instill a common land ethic in the public. We believe, and have shown several examples, that resources can be managed to produce marketable commodities as well as provide a wide range of non-market amenities within a framework that ensures sustainability.

Scale, scope, and temporal change are all critical factors in producing resources through ecosystem management. We have shown that a century-plus planning horizon must be considered before we can see what management activities are needed on the landscape today. Vegetative regimes constantly change, and the lack of direct intervention by human activities does not equate to protection in perpetuity. Not doing any vegetation management would have dire consequences in forests that have gone through major changes from their presettlement condition. Native species have adapted to a range of habitat patterns, as shown by historical disturbance events and ecological processes. This is one key to evaluating the impact of resource production on ecosystem health. We have shown in the Fish and Wildlife and other examples that long-range planning must consider not only change resulting from human activity but also natural changes resulting from vegetative succession. One way to assure integration of resource production and use into healthy ecosystems is to see that management activities mimic the patterns of natural disturbance (e.g., Crowley Project, Ponderosa Pine Forest Partnership).

We have shown that management approaches are available that manipulate vegetation and wildlife populations to produce healthy ecosystems. In fact, we have found that in some cases ecosystems must be treated to achieve ecosystem goals such as diversity and long term-sustainability (Crowley Project, Ponderosa Pine Forest Partnership, Blacks Mountain Experimental Forest Project, and others). We have found that traditional products and methods of extraction must sometimes be modified to deal with current ecosystem conditions. We have also shown that exploration and development of nonrenewable resources are possible if exploration is regulated to minimize impacts to ecosystems and if proposed restoration is compatible with long-term ecosystem sustainability.

REFERENCES

Algermissen, S.T., D.M. Perkins, P.C. Thenhaus, S.L. Hanson, and B.L. Bender. 1990. Probabilistic Earthquake Acceleration and Velocity Maps for the United States and Puerto Rico. U.S. Geological Survey Miscellaneous Field Studies Map, MF-2120, scale 1:7,500,000.

Anderson, S.J., and C.P. Stone. 1993. Snaring to control feral pigs *Sus scrofa* in a remote Hawaiian rain forest. *Biological Conservation* 63: 195–201.

Baker, J.K. 1979. The feral pig in Hawaii Volcanoes National Park. In: R.M. Linn (ed.), *Proceedings of Conference on the Scientific Research in National Parks*, Ser 5(1): 365–367.

Barbour, R.J., J.F. McNeel, S. Tesch, and D.B. Ryland. 1995. Management of mixed species, small-diameter, densely stocked stands. In: *Sustainability, Forest Health, and Meeting the Nations Needs for Wood Products, COFE 1995 Council on Forest Engineering Annual Meeting*, June 5–8, 1995, Cashiers, NC.

Bookstrom, A.A., G.L. Raines, and B.R. Johnson. 1995. Digital Mineral Resource Maps of Phosphate and Natural Aggregate in the Pacific Northwest: A Contribution to the Interior Columbia Basin Ecosystem Management Project. U.S. Geological Survey Open-File Report 96-681.

Bookstrom, A.A., M.L. Zientek, S.E. Box, P.D. Derkey, J.E. Elliott, D. Frishman, R.C. Evarts, R.P. Ashley, L.A. Moyer, D.P. Cox, and S.D. Ludington. 1996. Status and Contained Metal Content of Significant Base and Precious Metal Deposits in the Pacific Northwest: A Contribution to the Interior Columbia Basin Ecosystem Management Project. U.S. Geological Survey Open-File Report 95-688.

Brew, D.A., L.J. Drew, and S.D. Ludington. 1992. The study of the undiscovered mineral resources of the Tongass National Forest and adjacent lands, southeastern Alaska. *Nonrenewable Resources* 1(4): 303–322.

Cartledge, T.R., and J.G. Propper. 1993. Pinon–Juniper ecosystems through time: Information and insights from the past. pp. 63–71. In: Managing Pinon–Juniper Ecosystems for Sustainability and Social Needs. USDA Forest Service General Technical Report RM-236. U.S. Forest Service Rocky Mountain Forest and Range Experiement Station, Fort Collins, MO.

Cary, A.B., C. Elliott, B.R. Lippke, J. Sessions, C.J. Chambers, C.D. Oliver, J.F. Franklin, and M.J. Raphael. A Programatic Approach to Small-Landscape Management: Final Report of the Biodiversity Pathways Working Group of the Washington Landscape Management Project. Washington Landscape Management Project Rep. 2. Washington Department of Natural Resources, Olympia, WA (in press).

Cissel, J., F. Swanson, G. Grant, D. Olson, S. Gregory, S. Garman, L. Ashkenas, M. Hunter, J. Kertis, J. Mayo, M. McSwain, K. Swindle, and D. Wallin. A Disturbance-Based Landscape Design in a Managed Forest Ecosystem: The Augusta Creek Study. USDA Forest Service General Technical Report. U.S. Forest Service Pacific Northwest Station, Portland, OR (in press).

Colville National Forest. 1994. *CROP Creating Opportunities. A Study of Small-Diameter Trees of the Colville National Forest.* Colville, WA: USDA Forest Service, Colville National Forest.

Connor, R.C., J.D. Born, A.W. Green, and R.A. O'Brien. 1990. *Forest Resources of Arizona.* USDA Forest Service Resource Bulletin INT-69. U.S. Forest Service.

Cool, K. L. 1992. Seeking common ground on western rangelands. *Rangelands* 14(2): 90–92.

Debano, L.F., and L.J. Schmidt. 1989. Interrelationship between watershed condition and health of riparian areas in southwestern U.S. In *Proceedings, Riparian Resource Management Workshop*, May 8–11, Billings, MT.

DeBell, D., and J. Franklin. 1987. Old growth Douglas-fir and western hemlock: A 36-year record of growth and mortality. *Western Journal of Applied Forestry* 2(4): 111-114.

Dolph, L.K., S.R. Mori, and W. Oliver. 1995. Long-term response of old-growth stands to varying levels of partial cutting in the eastside pine type. *Western Journal of Applied Forestry* 10(3): 101-108.

Elmore, W., and B. Kauffman. 1994. Riparian and watershed systems: Degradation and restoration. *Ecological Implications of Livestock Herbivory in the West*. Society for Range Management.

Erickson, J.R., and D.E. Toweill. 1994. Forest health and wildlife management on the Boise National Forest, Idaho. pp. 389–409. In: R.N. Sampson and D.L. Adams (eds.), *Assessing Forest Ecosystem Health in the Inland West*. The Haworth Press, New York.

Frost, T.P., G.L. Raines, C. Almquist, and B.R. Johnson. 1996. Digital Maps of Possible Bat Habitats for the Pacific Northwest: A Contribution to the Interior Columbia River Basin Ecosystem Management Project, U.S. Geological Survey Open-File Report 95–683.

Gunther, T.M. 1992. Quantitative assessment of future development of copper/silver resources in the Kootenai National Forest Idaho/Montana. Part II — Economic and policy analysis. *Nonrenewable Resources* 1(4): 267–280.

Harris, L.D. 1984. *The Fragmented Forest: Island Biogeography and the Preservation of Biotic Diversity*. The University of Chicago Press, Chicago, IL.

Herbel, C.H. 1985. Vegetation changes on arid rangelands of the Southwest. *Journal of Range Management* 7: 19–21.

Hoblitt, R.P., C.D. Miller, and W.E. Scott. 1987. *Volcanic Hazards With Regard to Siting Nuclear Power Plants in the Pacific Northwest*. U.S. Geological Survey Open-File Report 87-297.

Hone, J., and W. Atkinson. 1983. Evaluation of fencing to control feral pig movement. *Australian Wildlife Research* 10: 499–505.

Hone, J., and C.P. Stone. 1989. A comparison and evaluation of feral pig management in two national parks. *Wildlife Society Bulletin* 17(4): 419–425.

Huenneke, L.F., and P.M. Vitousek. 1990. Seedling and clonal recruitment of the invasive tree *Psidium cattleianum*: Implications for management of native Hawaiian forests. *Biological Conservation* 53: 199–211.

Interagency Ecosystem Management Task Force. 1995. The Ecosystem Approach: Healthy Ecosystems and Sustainable Economies. Vol. I-Overview. PB95–265583. Available from National Technical Information Service, Springfield, VA.

Johnson, B.R., and G.L. Raines. 1995. Digital Map of Major Lithologic Bedrock Units for the Pacific Northwest: A Contribution to the Interior Columbia River Basin Ecosystem Management Project. U.S. Geological Survey Open-File Report 95–680.

Katahira, L.K., P. Finnegan, and C.P. Stone. 1993. Eradicating feral pigs in mountain mesic habitat in Hawaii Volcanoes National Park. *Wildlife Society Bulletin* 21: 269–274.

Laycock, W.W. 1991. Stable states and thresholds of range condition on North American rangelands: A viewpoint. *Journal of Range Management* 44(5): 427–433.

Marsh, S.P., S.J. Kropschot, and R.G. Dickinson (eds.). 1984. *Wilderness Mineral Potential — Assessment of Mineral Resource Potential in U.S. Forest Service Lands Studied, 1964-1984*. U.S. Geological Survey Bulletin 1300, vol. 1-2.

Maser, C. 1988. *The Redesigned Forest*. R. & E. Miles, San Pedro, CA.

Matter, W.J., and R.W. Mannan. 1988. *Sand and Gravel Pits as Fish and Wildlife Habitat in the Southwest*. Fish and Wildlife Service Resource Publication 171.

Mayo, J. 1995. *Young Stand Thinning and Diversity Study, Willamette National Forest*. Central Cascades Adaptive Management Area. Irregular Publication.

Myers, L.H. 1989. Grazing and riparian management in southwestern Montana. In: *Proceedings, Riparian Resource Management Workshop*, 1989 May 8–11, Billings, MT.

National Research Council. 1994. *Rangeland Health: New Methods to Classify, Inventory, and Monitor Rangelands*. National Academy Press, Washington, DC.

Perlin, J. 1989. *A Forest Journey: The Role of Wood in the Development of Civilization*. W.W. Norton, New York.

Platts, W.S., C. Armour, G.D. Booth, M. Bryant, J.L. Bufford, P. Cuplin, S. Jensen, G.W. Lienkaemper, G.W. Minshall, S.B. Monsen, R.L. Nelson, J.R. Sedell, and J.S. Tuhy. 1987. Methods of Evaluating Riparian Habitats With Applications to Management. USDA Forest Service General Technical Report INT-221. Ogden, UT: U.S. Forest Service, Intermountain Research Station.

Raines, G.L., and C.L. Smith. 1996. Digital Maps of National Uranium Resource Evaluation (NURE) Geochemistry for the Pacific Northwest: A Contribution to the Interior Columbia Basin Ecosystem Management Project, U.S. Geological Survey Open-File Report 95–686.

Raines, G.L., B.R. Johnson, T.P. Frost, and M.L. Zientek. 1996. Digital Maps of Compositionally Classified Lithologies Derived From 1: 500,000 Scale Geologic Mapping For the Pacific Northwest: A Contribution to the Interior Columbia Basin Ecosystem Management Project. U.S. Geological Survey Open-File Report.

Ryland, D. 1996. Evaluating the Impact of Four Silvicultural Prescriptions on Stand Growth and Structure in Northwest Washington — A Modeling Approach. Master's of Forestry Report (unpublished). Oregon State University, Forest Resources Department, Corvallis, OR.

Salwerowicz, F. 1994. Mineral development and ecosystem management. In: *Proceedings, Third International Conference on Environmental Issues and Waste Management in Energy and Mineral Production*, 1994 August 30–September 1, Perth, West Australia. Curtin University of Technology 1-14.

Sharpe, M., D.L. True, J.E. Bowns, J.E. Burkhart, S. Tixier, B. McQuivey, D. Vail, H.J. Box, and D. Boe. 1992. Rangeland Program Initiatives and Strategies: Report of the Blue Ribbon Panel to the National Public Lands Advisory Council. Washington, DC: National Public Lands Advisory Council.

Singer, D.A. 1975. Mineral resource models and the Alaskan Mineral Resource Assessment Program. pp. 370–382. In: W.A. Vogely, (ed.), *Mineral Materials Modeling — A State-of-the-Art Review*. Johns Hopkins University Press, Baltimore, MD.

Singer, D.A. 1993. Basic concepts in three-part quantitative assessments of undiscovered mineral resources. *Nonrenewable Resources* 2(2): 69-81.

Singer, F.J. 1981. Wild pig population in national parks. *Environmental Management* 5: 363–370.

Stone, C.P., and L.L. Loope. 1987. Reducing the negative effects of introduced animals on native biotas in Hawaii: What is being done, what needs doing, and the role of National Parks. *Environmental Conservation* 14: 245–258.

Sundberg, U.L., J. Lindegren, H.T. Odum, and S. Doherty. 1994. Forest energy basis for Swedish power in the 17th century. *Scandinavian Journal of Forest Research*, Supplement 1.

U.S. Fish and Wildlife Service. 1993. *1991 National Survey of Fishing, Hunting, and Wildlife — Associated Recreation*. U.S. Government Printing Office, Washington, DC.

USDA Forest Service and U.S. Dept. of Interior, Bureau of Land Management. 1994. Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl. [publisher unknown]

Van Hooser, D.D., D.C. Collins, and R.A. O'Brien. 1993. Forest Resources of New Mexico. INT-79. USDA Forest Service, Intermountain Research Station.

Vtorov, I.P. 1993. Feral pig removal: Effects on soil microarthropods in a Hawaiian rain forest. *Journal of Wildlife Management* 57(4): 875–880.

Welsch, D.J. 1991. Riparian Forest Buffers. Report NA–PR–07–91. Radnor, PA: USDA Forest Service, Northeastern Area, State and Private Forestry.

Yaffee, S.L. 1994. *The Wisdom of the Spotted Owl: Policy Lessons for a New Century*. Island Press, Washington, DC.

Zientek, M.L., A.A. Bookstrom, S.E. Box, and B.R. Johnson. 1996. Future Minerals Related Activity, Interior Columbia Basin Ecosystem Management Project. U.S. Geological Survey Open-File Report 95–687.

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